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ABSTRACT

Intestinal parasites have become a serious public health problem in tropical countries because of the climate and the difficulty of achieving efficient hygiene. The objectives of this journal issue are to increase awareness of the individual and collective repercussions of intestinal parasites, describe the current conditions of contamination and clinical actions for parasites, and foster health education as a means of preventing infestation. The journal issue explains various types of parasites, including their epidemiology, symptoms, and different means of diagnosis. These explanations are organized according to different means of transmission: fecal/oral transmission, food transmission, and transcutaneous transmission. The issue also notes that controlling intestinal parasites can be achieved by the use of active drugs, the main features and indications of which are determined by the different types of worms. The spread and transmission of the disease can be stopped by interrupting completely the epidemiological chain at any one point. The journal issue concludes with the statement that the most important factor in prevention is public health awareness among community leaders and the improvement of health status by means of health education. (AP)

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INTESTINAL PARASITOSES

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CHILDREN
IN THE TROPICS

REVIEW OF THE INTERNATIONAL CHILDREN'S CENTRE

INTESTINAL PARASITOSES

BERNARD LAGARDERE
ELISABETH DUMURGIER

1994 - N° 210

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INTRODUCTION

Intestinal parasites exist everywhere in the world, but they are a real public health problem in tropical countries, because of the climate and the difficulty of achieving efficient hygiene.

The global estimation of parasite-ridden individuals yields approximate figures which only give a general idea. According to WHO, 3 billion people around the world have intestinal worms.

The repercussions on health and the social situation are usually overlooked or minimized. These parasitoses are often latent, or produce only minor direct clinical signs. It is above all their nutrition-related repercussions which cause a public health problem, inasmuch as they are partially or totally responsible for malnutrition and its consequences. The social repercussions are tied to this induced malnutrition, as well as to the burden of medical and health expenditures imposed by these parasites and by their adverse effects.

The extent of parasite infestation has not declined despite the present availability of drugs capable of rapidly overcoming most agents. They are usually expensive in the personalized medical circuit, and the persistence of the epidemiological chain makes rapid recontamination probable if not unavoidable. Less spectacularly but more effectively, individual and collective measures aimed at interrupting the chain of transmission have reduced the pandemicity in Northern countries. This is a tremendous public health problem, but one which is potentially susceptible of solution.

Objectives

The objectives of the present issue are :

- to increase awareness of the individual and collective repercussions of intestinal parasites ;

- to describe the conditions underlying contamination and the clinical expression of parasites ;

- to identify the means of curative and preventive action, especially in the framework of education for health.

Definitions

A parasite is an organism which derives its nourishment at the expense of another organism known as the host during all or part of its life. It differs from a saprophyte, which lives in or on a host organism but does not feed at its expense. There are intestinal parasites such as ancylostomas, which feed on any blood that runs into the intestine, and intestinal saprophytes such as the amoebae of the colon (Entamoeba coli), which only eat food residues in the gut lumen.

A parasite may have several hosts. The final host is the one in which the parasite undergoes its reproductive cycle. It constitutes the parasite reservoir, whereas the other host or hosts are intermediate ones.

Types

Classification of intestinal parasites usually divides them into several types.

Zoologically speaking, there are unicellular organisms (amoebae), which are protozoans, and pluricellular ones (worms), which are metazoans.

The protozoans include amoeba (Entamoeba histolytica), giardia (Giardia lamblia) and cryptosporidium (Cryptosporidium parvum).

In the metazoan category, intestinal worms, or helminths, include :

- roundworms (nemathelminths), the ascaris (Ascaris suum), oxyuris (Enterobius vermicularis), ancylostome (Ancylostoma duodenale and Necator americanum), anguillula (Strongyloides stercoralis), trichina (Trichinella spiralis) and trichuris (Trichuris trichura) ;

- flatworms (plathelminths), taenias (Taenia saginata, Taenia solium, Hymenolepis nana), flukes, schistosomes (Schistosoma intestinalis).

Depending on their feeding mechanism, they are divided into :

- haematophages (amoebae and ancylostomes), which thrive on the blood of their host, and therefore cause damage to the mucosa ;

- non-haematophages (ascaris, oxyuris), which do not require blood, and therefore damaged mucosa, for sustenance in their adult form.

The mode of contamination divides them into :

- parasites that enter the body through the digestive track (ascaris) ;

- parasites entering the body through the skin (anguillula).

Depending on their location within the host organism :

- tissue parasites live in the walls or vessels of the digestive track (trichina, schistosomes) ;

- others live in the gut lumen : in the duodenum (anguillula), the jejunum (ascaris), the caecum (oxyuris) or the colon (amoebae).

These different peculiarities have repercussions on the host-parasite relationship and account for the potential dangers involved.

Cycles

It is also important to understand the parasite's complete life pattern, or cycle, of which the "parasitic" stage may only be one part. These different stages point to the sensitive moments, when control strategies have the best chances of being effective. These targets are often more easily reached outside of the host than in the parasite-ridden patient.

In direct cycles, the parasite has a single host. The parasite may spend its entire life in the body of the host or, more frequently, partially in the outside environment. This external phase is some-

times essential, since it enables the parasite to mature, and hence to pursue its development : this is then called a **long, direct cycle.** This stage may be extremely short, with forms that are immediately mature (and contaminating) : the **cycle is short,** then.

In indirect cycles, there are several parasite hosts, from different species. If one of them is an insect which transmits the parasite through its bite, it is known as a vector. If not, the other hosts are passive ones, which the parasite must meet one after the other, to complete its evolution. The host in which its sexual reproduction occurs, if any, is known as the final host or parasite reservoir.

The first part of this issue describes the different intestinal parasites on the basis of their mode of contamination, with reference to their epidemiological specificity, the medical conditions they cause and the diagnostic means useful for identifying them.

The second part deals with how to control intestinal parasites, because of their impact, in terms of public health. This control requires the use of drugs, but also involves preventive measures and education for health.

INTESTINAL PARASITES

Children may be contaminated by intestinal parasites of various types and sizes and with different consequences. There are three main processes :

- ingestion of infesting forms through faecal contamination, and which can be avoided by hand-washing and cleanliness in food preparation. This is termed faecal/oral transmission (for oxyuris, ascaris, trichuris, hymenolepis, amoeba, giardia) ;

- ingestion of an intermediate host, with infesting forms contained in or carried by its muscle tissue (beef taenia, pork taenia, trichina) ;

- the transcutaneous penetration of infesting larvae living in mud (ancylostome, anguillula) or in fresh water (schistosome).

FAECAL/ORAL TRANSMISSION

OXYURIS

Epidemiology

Enterobius vermicularis (the pinworm) is a round, whitish worm that is visible to the naked eye when it comes out in the stools. It measures from 1 mm (for female worms) to 5 mm (for males). It is threadlike and motile. This is the worm that parents are most likely to recognize.

The adult worms, which live for 1 to 2 months, reside preferentially in the caecum and the appendix, where they feed on food residues and on faecal matter. Once fertilized, the females migrate to the rectum and the anal canal, mostly in the evening, and deposit thousands of eggs there (5,000 to 15,000 per female worm).

When laid, the eggs already contain a fully formed embryo : they are immediately contaminating, then. Once deposited on the skin of the anal margin, they fall onto the stools and are eliminated with them. They are highly resistant (they may live for 3 weeks at a temperature of 17-20°C) and may contaminate food and thereby infest another person. Once ingested, the egg produces a larva, which reaches adulthood within 2 weeks to one month, through successive moulting. Auto-reinfestation is frequent, when the child scratches the anal region, since the female worms bite, causing itching : the eggs stick to the nails and hands, which are put to the mouth, causing ingestion of the eggs, which then become adult worms.

Humans are the only host for this parasite. They are therefore the only reservoir. The tremendous fertility of the females and the type of contamination explain why children are most often infested (anal itching, finger-sucking), but this parasitosis is extremely prevalent, including in adults, where it is often latent. Contagion within families or in communal situations is extreme, requiring curative treatment of the entire family to avoid reinfestation, which is practically unavoidable in the absence of medication. This is a very cosmopolitan parasitosis, perhaps more frequent in hot, humid climates, and especially in places where faecal hygiene is more difficult to implement, and less reliable (cf. figure 1).

Symptoms

Oxyuriasis, or enterobiasis, is often latent and goes unnoticed, which in itself is conducive to contamination. The main clinical sign, if any, is anal itching, especially in the evening. Sometimes examination shows inflammation of the anal margin and more rarely, local purpura, indicative of worm bites. Itching may be so great that it produces scratching lesions, which may infect proximal regions, with perineal eczema, and recurrent urinary infections in girls. In infants, it occasionally causes behavioural disorders, with irritability, nightmares or night frights and gnashing of teeth. But oxyuriasis never causes convulsions or other neurological signs.

Oxyuriasis may cause repeated abdominal pain, but the latter is a very unspecific sign in children. Appendectomies very often bring pinworms to light. The idea that they play a direct role here is questionable. The worm definitely may induce abdominal pain which may be taken for appendicitis and therefore motivate the operation. It is improbable that these worms are capable of inducing true appendicitis. Even so, they are commonly found in conjunction with inflammatory lesions, since they are located in the caecal/appendix region. Similarly, oxyuris alone can hardly be made responsible for diarrhoea and vomiting.

Diagnosis

The diagnosis is often based on the discovery of worms on the surface of the faeces or on or around the margin of the anus, even when no clinical symptoms are present. The description may be somewhat fanciful, especially as to the size of the worms seen. Drawings must be shown to determine the scale more accurately. However, the fact that the worms are thin and threadlike is easily noticed. In these cases the worms are often extremely numerous.

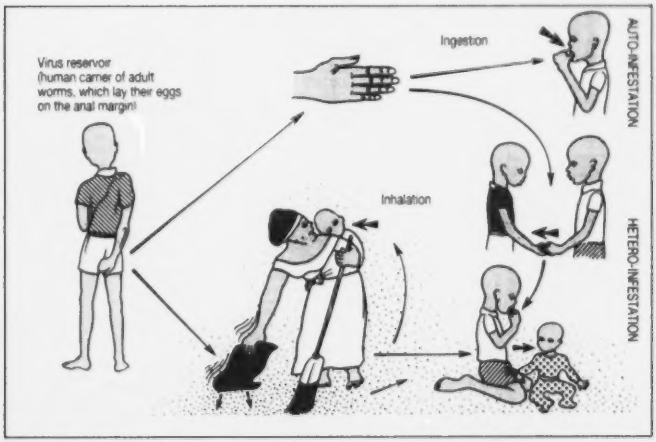

Figure 1 : Dissemination of and contamination by oxyuris.

Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Épidémiologie. Prophylaxie. Paris : Les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

Examination of faeces in search of oxyuris eggs is often disappointing and useless : the eggs are laid elsewhere, and are mostly found on the skin around the anus. The best way to find them is known as the Scotch tape test, using Graham's adhesive cellophane : in the morning, upon waking, before any washing, the skin of the anal margin is smoothed, by hand, and the adhe-

sive side of a piece of transparent Scotch tape, which has been stretched in U-shape over a test tube beforehand to avoid contamination of the fingers, is applied. The eggs adhere to the tape, which may then be placed on a slide and examined under a microscope.

The irregularity with which females lay accounts for the fact that eggs cannot always be found. However, it is important to combat the "obsessions" of some families who constantly demand treatments for oxyuriasis although it has already been cured.

Exceptionally, moderate hypereosinophilia (less than 10 %) may be seen : it is of course non-specific. Presumptively, a diagnosis of oxyuriasis does not account for hypereosinophilia. This diagnosis can only be deduced by elimination if this blood sign disappears when the worms are destroyed.

ASCARIS

Epidemiology

Ascaris lumbricoïdes is a roundworm, 20 to 25 cm long and 5 to 6 mm in diameter in the case of females. Males are somewhat smaller (15-17 cm by 2-4 mm), and are pinkish-white in colour. They are highly motile, especially when expelled in the stools or during vomiting.

The worms live in the small intestine (the ileum), where they feed on the gastric contents. Females may lay huge numbers of eggs (200,000 a day) in the small intestine, from which they are evacuated with the stools. Eggs are not yet embryonated at this point. To become infesting, they must find a location with a specific degree of heat and humidity (a moist ground, at a temperature of 28-30°C). The embryo then develops within 30 to 40 days. This compulsory stay in an external environment explains why autoinfestation cannot occur. Their thick shell makes the eggs highly resistant. When expelled in the stools, they are capable of sustaining deep-freezing, and only embryonate when they encounter suitable conditions. When the surroundings and the situation permit, they may retain their ability to infest for more than ten years. Wet tropical areas are ideal for their conservation. In the Sudanese/sahelian climate, transmission is seasonal (during the rainy season). Contamination occurs through the intake of embronated eggs along with soiled food. They cannot be killed by salt, vinegar, alcohol or bleach : only cooking can destroy them.

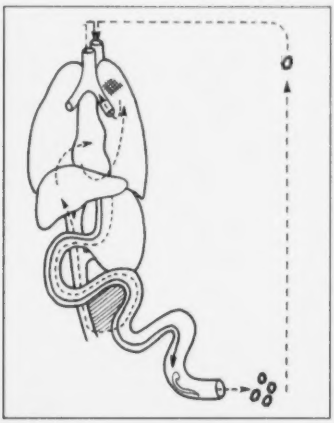

Figure 2 : Complete cycle of the human ascaris (A. lumbricoides).

Source : Gentilini M. et col. Maladies parasitaires. Paris : J.B. Bailliere, 1981.

Once it reaches the stomach, the egg hatches a larva which crosses the intestinal wall, migrates to the liver and then to the heart, through the vena cava, and subsequently to the lungs. Toward the 10th day of the cycle, it crosses into the alveola, travels up the bronchi and the trachea to the pharyngolaryngeal opening and through the oesophagus, reaches the small intestine, in which it attains adulthood. This complex larval migration phase takes a long time : 2 to 3 months elapse between contamination and the discovery of eggs in the stools, indicating that the larvae have moulted into adults in the intestine (cf. figure 2).

Humans are the only reservoir for this parasite (but there are other types of ascaris specific to certain animals such as cats and dogs). The highly cosmopolitan nature of this disease is explained by the great fertility of females and the fact that eggs are able to survive in varying climates. This parasitosis is strictly dependent on food hygiene (cf. figure 3).

Symptoms

Ascariasis may be latent, and discovered during routine laboratory examination of stools to detect parasites, or when defecation or vomiting spectacularly reveals the presence of adult worms.

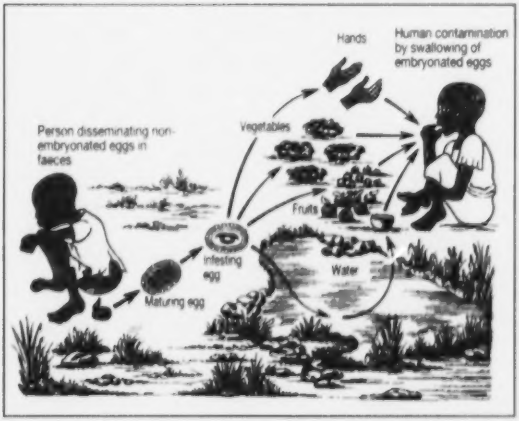

Figure 3 : Dissemination of and contamination by ascaris.
Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Epidémiologie. Prophylaxie. Paris : les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

During the larval migration phase, there are usually no clinical signs. Exceptionally, there are some indications of an allergic reaction, rather than of any damage caused by the larvae themselves. These include coughing and occasional urticarial rashes suggestive of asthma. Chest x-rays are indicative when passing opacities are seen in one or two pulmonary fields. There is considerable hypereosinophilia.

In the ileum, adult worms may be well tolerated if there are not too many. They mostly produce non-specific abdominal pain, exceptionally constipation or diarrhoea, with anorexia and bloating. Because they are highly motile, the worms may cause surgical complications requiring emergency action, such as in appendicitis with inclusion of worms, peritonitis, pancreatitis, abscess of the liver with the bile or pancreatic ducts blocked by worms, occlusion by a cluster of worms. Such occurrences are infrequent and are discovered on the operating table only.

When a great many worms are present they may be an obstacle to the host's nourishment, and contribute, along with other factors, to actual malnutrition, even when no digestive disorders are present.

Diagnosis

During the adult stage and in the absence of spontaneous excretion of adult worms, only laboratory examination makes diagnosis possible. There are generally many eggs, easily identifiable by their thick, dimpled shell measuring about 50 microns across. At this point, eosinophilia is normal or slightly elevated, and immunological tests are useless.

The problem of diagnosis rarely arises during the larval phase. No eggs are found in the stools, since the worms have not yet reached adulthood. The most suggestive biological sign is hypereosinophilia, which peaks 3 to 4 weeks after infestation (at 30 to 50 %), and declines thereafter until it levels off at a moderate

figure two months later, when the larvae have gone through their cycle and eggs, indicative of the presence of adult worms, are found in the stools.

Usually it is the question of the cause of the hypereosinophilia that brings it to light. If the blood sign subsides at the end of 3 weeks, ascariasis may be the cause even in the absence of clinical signs. This can only be corroborated when eggs are discovered in the stools two months after the presumed date of infestation.

TRICHURIS

Epidemiology

The pathogen is a roundworm, Trichuris trichura (or whipworm), measuring 3.5 to 5 cm when adult. The proximal end is long and hairlike, and burrows into the digestive mucosa while the posterior end is short and thicker. The worm is a blood-eater : it damages the mucosa and absorbs the blood that comes out, but the amount absorbed is minimal (0.005 ml per worm and per day), less than what is eaten by ancylostomes.

The adult worm usually lives in the caecum, more rarely in the rest of the colon. The females lay non-embryonated eggs, which are eliminated in the faeces. A stay of at least 6 weeks in a hot, humid external environment (and longer in colder weather) is required for the formation of an embryo. The egg is highly resistant. Contamination is oral, through ingestion of eggs with soiled food. The larva then travels to the caecum, where it develops into an adult. Egg-laying begins about one month after infestation.

Humans are the only parasite reservoir. This parasite is found everywhere around the world, but is most frequent in hot, humid areas and in places where hygiene is most deficient.

Symptoms

This parasitosis usually does not induce any clinical signs.

In case of very heavy infestation in infants, glairy, bloody diarrhoea of the dysentery type may be seen. Rectal prolapse is habitual.

Even when no specific clinical signs are present, the trichuris, which generates chronic loss of iron, contributes to the exacerbation of iron-deficiency anaemia and malnutrition.

Diagnosis

Diagnosis is based on laboratory examination of faeces, showing easily recognized eggs : they are 50 microns long and 25 microns in width, are lemon or football-shaped, and contain a single cell.

AMOEBA

The Entamoeba histolytica pathogen is a unicellular protozoan which may take two forms in the intestine.

Epidemiology

There is a vegetative, motile form, which in turn may be of one or two sorts :

- first, Entamoeba histolytica minuta (E. h. minuta), measuring about 15 microns in diameter, which feeds on the gastric contents, never contains any blood corpuscle and causes no illness ;

- secondly, Entamoeba histolytica histolytica (E. h. histolytica), larger in size (15 to 40 microns), which penetrates the digestive wall where it causes abscesses, and feeds mostly on blood corpuscles which are visible in its cytoplasm. This is the blood-eating amoeba, which causes amoebiasis.

The resistance form is motionless : it is a round cyst, 15 microns across, produced by E. h. minuta and evacuated in the faeces.

E. h. minuta lives as a saprophyte in the caecum. The cyst, or resistance form, is eliminated with the faeces. When it leaves the human body it is directly contaminating and highly resistant. It retains its infesting potential for 5 to 15 days in faeces, resists at low temperatures but is rapidly destroyed by heat above 55°C. None of the antiseptics generally utilized to disinfect water destroys these cysts. The only effective measure is to soak vegetables in a 200 ppm lugol solution, but this gives food an unpleasant taste.

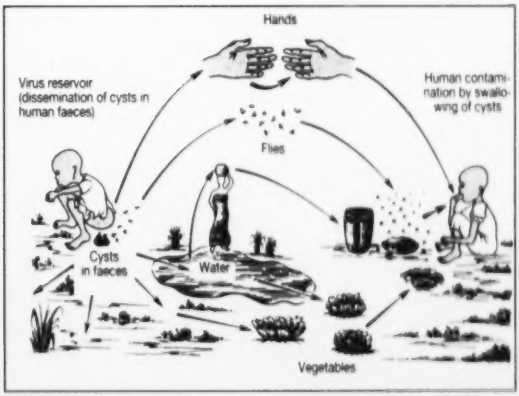

Figure 4 : Dissemination of and contamination by amoebae.

Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Epidémiologie. Prophylaxie. Paris : les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

Contamination is either direct, borne by dirty hands (auto-infestation, family cases, health workers, laboratory) or indirect, through the intake of food handled by carriers of cysts or by drinking water that has been soiled by human excrements (cf. figure 4).

Humans are the only parasite reservoir, but it does seem that flies and cockroaches may play host to cysts. This is a cosmopolitan parasitosis, but it is mostly seen in hot, humid countries where hygiene is deficient. The conditions under which a saprophytic amoeba (E. h. minuta) turns into a pathogen (E. h. histolytica) are not known.

Symptoms

The amoeba may continue to live in the minuta form in the intestine for some time, sometimes forever, in which case there are no clinical symptoms. However, "symptom-free carriers" are a source of undetected contamination.

When the amoeba becomes pathogenic (E. h. histolytica), the first lesion is always in the intestine. It causes colitis, responsible for dysentery, with colicky abdominal pain, false alarms, painful defecation. The stools are typically essentially composed of glair, blood and pus, with no faecal matter. There is no fever, and dehydration is exceptional. Often the picture is much less suggestive, and is similar to common infectious diarrhoea or abdominal pain. In children, there is hardly ever an evolution to chronic colitis, and the symptoms usually disappear in a matter of days, but the amoebae continue to be evacuated in the stools, and may cause a relapse or affect another location.

Once the intestines are damaged and the amoebae are in contact with the gastric blood vessels, they may be carried to the liver and more exceptionally to other viscera, where they generate abscesses. Amoebic hepatitis consists of small, disseminated loci which run together into one or several abscesses, sometimes quite large in size. The picture includes deep suppuration with impairment of general health, high fever, sometimes oscillating, extremely intense pain in the liver region, irradiating to the shoulder and increased by palpation ; it is suggestive of a liver abscess of either bacterial or amoebic origin. Hyperleukocytosis and a biological inflammatory syndrome are other shared features. Ultrasound biometry reveals the presence of one or several fluid-filled cavities, and guides puncture. Chocolate-brown pus (haemorrhagic) is a key argument in favour of amoebiasis, but nonetheless, objective proof resides in the identification of amoeba in the puncture material. Other visceral locations (lung, brain, skin) are exceptional.

Diagnosis

Diagnosis is based on the evidencing of the amoeba in its haematophagic, histolytica form.

In amoebic colitis, laboratory examination of stools is of diagnostic value. It requires recently evacuated stools (in the last 3 hours), and especially the glairy parts. When they are numerous, haematophagic amoebae with blood cell inclusions in their cytoplasm are easy to recognize.

Often only E. h. minuta forms and cysts are seen. This entails two problems : differential diagnosis and proof of the parasite's participation in the symptoms. Only an experienced microscopist is able to distinguish between this form of the amoeba or cyst and other parasites which are never pathogenic (other amoebae colonizing the colon). When cysts with 4 nuclei are documented, they afford definite proof of the presence of amoeba histolytica. But does this mean that these amoebae are responsible for the clinical signs, if no haematophagic form has been detected ? This may be debatable but the patient, being a carrier and therefore a source of contamination at the very least, must be treated.

When a liver abscess exists, the presence of amoebae in the stools, be they minuta or haematophages, suggests that the abscess may be amoebic, but does not constitute proof. Objective proof is afforded by the presence of amoebae in the pus obtained by puncture. A high serum antiamoeba antibody concentration is also of diagnostic value, since only a visceral location of the amoebae is capable of inducing such high levels, whereas the concentration is low or nil in amoebic colitis.

GIARDIA

Epidemiology

The pathogen is a flagellate protozoan, a racket-shaped unicellular organism measuring 10 to 20 microns, with four pairs of flagella which afford mobility. It sticks to the intestinal cells and feeds on the gastric contents. The resistance form (cyst) is oval, measures 10 to 30 microns with a smooth, enclosing capsule surrounding the flagella.

The preferred location of these parasites, in their saprophytic state, is the duodenum. Under certain conditions (proliferation, immunocompromise), they may damage the intestinal cells, thereby causing malabsorption. Cysts travel with the faecal matter and are evacuated in the stools. They are directly contaminating, through dirty hands and soiled drinking water and vegetables. They are highly resistant outside of the body, and tolerate temperatures ranging from 0 to 50°C. They may retain their infesting ability for several months in hot, humid tropical climates. The ease with which contamination occurs explains why this parasitosis is so widespread in collective situations such as daycare units, groups of children in general, and families.

Humans seem to be the only parasite reservoir (possibly along with some primates). It is cosmopolitan in its geographic distribution, including both temperate and tropical regions, and is greatly encouraged by faulty hygiene. Infestation is mostly seen in children because faecal/oral hygiene is more difficult to enforce in them, or because of greater receptivity.

Symptoms

In most cases, the disease goes unrecognized, with no clinical sign of parasitism. These symptom-free carriers are a major source of contamination.

Some digestive symptoms may be connected with the presence of giardia. These include abdominal pain, especially in the right hypochondrium, along with typically yellow, foamy diarrhoea in infants, with hardly any dehydration, and lasting longer than common acute diarrhoea (one week).

Exceptionally, and apparently when underlying immunocompromise (an immunoglobulin deficit) is present, there may be chronic diarrhoea with malabsorption, causing or exacerbating undernourishment. Biopsy of the small intestine would then point to more or less severe villous atrophy, which regresses following treatment. Unlike other parasitic diseases (such as cryptosporidiasis), there is no special giardiasis-related clinical picture during AIDS.

Diagnosis

Diagnosis is achieved through microscopy of stools. When cysts are found the presence of the parasite may be assumed, but not necessarily its pathogenicity. Vegetative forms are only identified in the stools when proliferation exists. When these are evidenced, they argue strongly in favour of the parasite's implication in clinical disorders. Lack of faecal evidence does not necessarily preclude this diagnosis. Other examinations focussing more directly on the duodenum have been suggested (duodenal aspiration, duodenojejunal biopsy), but they can only be performed in a specialized hospital setting.

CRYPTOSPORIDIUM

The pathogen is a round, unicellular parasite of the coccidium family, living under the brush-like border of the intestinal cells, without invading the cytoplasm.

Epidemiology

The parasites (trophozoites) split up into merozoites, which invade the neighbouring cells. Certain merozoites yield gametes, which are fertilized in the gut lumen. The resulting zygote (egg) then turns into several sporulated oocysts. Zygotes and oocysts are eliminated with the stools, and are directly infesting if they enter the digestive track. The oocyst then invades an intestinal cell and continues the cycle.

Cryptosporidium parasites humans and many animals, both wild and domesticated. Two species affect humans : c. parvum and c. muris. They seem to be cosmopolitan, but their geographic distribution is not yet accurately known.

Symptoms

Several years ago, cryptosporidium was discovered to be the cause of diarrhoea during AIDS. It seems to play a major role in this context in tropical countries, by inducing chronic digestive disorders and severe undernourishment.

In children whose immunocompetence is not impaired by an AIDS-related problem, cryptosporidium may cause acute diarrhoea, lasting 2 to 5 days, with no special signs, and which subsides spontaneously.

Systematic studies increasingly reveal the existence of this parasitic disease in a latent phase, with no symptoms. This symptom-free carrier state is more prevalent in groups of children.

Diagnosis

It is based on microscopy, but requires enrichment techniques, and above all certain stains (fuchsin, using Ziehl's method). Smears taken from stools show parasites as small, red discs.

HYMENOLEPIS

This is the only taenia, or tapeworm, to be transmitted directly from one human host to another. The pathogen is a flat, ribbon-like worm measuring 1 to 3 centimetres (it is the smallest human taenia), segmented into 100 to 200 rings.

Epidemiology

It lives in the human digestive track. The mature rings detach themselves and are evacuated in the stools ; often they are partially destroyed, and release eggs. The latter contain an embryo, and are immediately infesting. There does not seem to be any intermediate host. Dirty hands or contaminated food transmit the eggs, which release an embryo once they reach the intestine. The embryo then enters the mucosa, where it turns into a cysticercoid larva. Following maturation, it achieves adulthood and moves to the gut lumen in about two weeks. Auto-infestation similar to that seen in oxyuriasis is possible.

This is a cosmopolitan disease, but is exceptional in temperate regions. It is mostly frequent around the Mediterranean basin (in North Africa), in Asia (Japan and India) and in South America, but less so in subsaharian Africa.

Symptoms

This parasitic disease is often latent, and may persist for more than 7 years, through auto-reinfestation, without any particular clinical signs.

When infestation is considerable (several hundred worms), the usual signs of taeniasis may be observed, with impaired appetite, abdominal pain, and occasional transit disorders. Some non-digestive symptoms such as emotional disturbances, difficulty in sleeping, and allergy-type signs (urticaria, rash, Quincke's oedema) have been described.

Diagnosis

Laboratory examination rarely discovers rings, but microscopy more frequently discovers eggs, measuring 40 to 50 microns and containing the hexacanth embryo surrounded by a two-layered shell.

TRANSMISSION BY FOOD

For certain intestinal parasites, contamination depends on the intake of those foods that constitute the main host of the intermediate form. Type of diet and eating patterns (with the corresponding customs and taboos) play an essential role here.

TRICHINA

The agent, trichinella spiralis is a small roundworm less than one-half centimetre long. This pathogen lives in the small intestine of humans and of many mammals.

The female produces larvae which rapidly cross the digestive wall and follow the lymph, and then the blood, to the heart, which distributes them throughout the body. However, they can only pursue their life cycle in the muscles, where they grow, undergo transformations and are subjected to a conjunctive reaction producing cysts one-fourth to one-half millimetre long. When the muscle (meat) is eaten, the cysts are ingested and cause contamination. The larvae are then released, and they achieve the adult stage in the host's digestive track in about two weeks. The cycle is only possible, then, if it includes carnivorous and omnivorous animals. In wild trichinosis, wolves, foxes, bears, rats, wart hogs and wild cats are involved. In domestic trichinosis, rats and pigs play a key role. Human contamination usually occurs through consumption of raw or insufficiently cooked pork meat. Pork meat preparations are just as dangerous as butchered meat. Smoking does not affect the larvae : only an 18°C Baumé brine is capable of killing them. A very few larvae (50) suffice for human infestation.

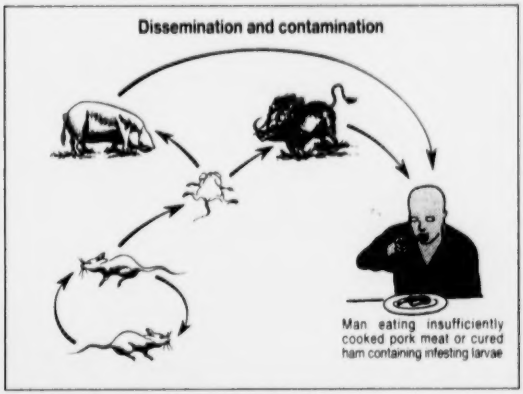
Dissemination and contamination
Man eating insufficiently cooked pork meat or cured ham containing infesting larvae

Figure 5 : Human infestation by trichina.

Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Epidémiologie. Prophylaxie. Paris : les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

A new possibility has recently been added to this usual type of contamination : the consumption of poorly cooked horse meat. Horses, which are herbivorous, can only be contaminated by a plant-based fodder containing the remains of rats who fed on it during the industrial processing phase.

There are many, varied parasite reservoirs. For humans, in tropical regions, the main reservoirs are swine (pigs and wart hogs) and the many wild carnivorous animals (jackals, coyotes and dogs) (cf. figure 5).

Trichinosis is cosmopolitan, although it seems to be infrequent in South America. Because contamination is usually carried by pork meat, it is not found in orthodox Muslim and Jewish communities.

Symptoms

Symptoms depend on the parasite cycle, the extent of contamination and the sensitivity of the infested individual.

Within a week of the contaminating meal, a picture involving digestive disorders similar to those seen in typhoid fever may be seen, with high fever, abdominal pain, diarrhoea and vomiting. The fever may last for two to three weeks, whereas the digestive signs are fleeting. However, the symptoms are often mild, and this period may go unnoticed.

Some time later, signs connected with larval migration and their enclosure in the muscles develop. Muscular pain is diffuse, but predominantly located in the chewing muscles and around the eyes. They are often attended by swelling of the face and eyelids, sometimes extending beyond this area, and by signs of allergy, with rashes, painful joints and dyspnoea. Fever is frequent at this point.

Once the larvae are encysted in the muscle tissue, systemic signs (fever) subside gradually, but the pain subsists for several months. In case of massive infestation, some fatal forms have been documented, exceptionally, stemming from encephalitis, myocarditis, bronchopneumonia or kidney failure.

Diagnosis

Eosinophilia is constant, and often very high. There is usually an inflammatory syndrome, with an increment in muscle enzymes.

Isolation of the parasite is exceptional and difficult. Adult worms may theoretically be found in the stools at the very outset of the digestive symptoms. From the third week of the disease on, muscle biopsy might discover encysted larvae.

Serology, using fluorescence immunoassay of a frozen cross-section of the trichinous muscle, is usually utilized for diagnosis. This is only feasible in specialized laboratories.

BEEF TAPEWORM

Epidemiology

The pathogen is a flatworm (Taenia saginata) 4 to 10 metres long. Its head (scolex) is provided with suction cups which enable it to adhere to the small intestine. Its body is composed of some 2,000 rings, the last of which, measuring about 2 cm, are shed and pass through the anal sphincter independently of the faeces. They may be found in underwear and bedding.

The detached rings, full of eggs (embryophores), fall to the ground. They disintegrate, and release their contents. The eggs are ingested by herbivorous animals (cattle, zebras) along with any nearby plants. The embryo then crosses the intestinal wall and migrates to the fatty intermuscular tissue. Within 3 to 4 months it is transformed into a cyst-like larva (cysticercus) measuring one-half centimetre across. Humans are infested when they eat the meat of the host beef, if it has not been cooked well enough to destroy the cysticercus larvae. The larva then becomes an adult taenia within

3 to 4 months and begins to shed its rings. Its presence prevents recontamination : the French call it the "solitary worm".

Humans are the only final host in which the worm lives its adult life. In addition to beef cattle, some other ruminants may act as intermediate hosts. These include antilopes, camels, sheep and goats. The disease is cosmopolitan ; its presence depends on available food and eating patterns. It seems to be frequent in Africa (cf. figure 6).

Symptoms

Often the disease is latent, and revealed by the discovery of rings, as the result of which many unrelated symptoms are sometimes attributed to the presence of the worm.

Diagnosis

The usual signs, known as taeniasis, combine digestive disorders (anorexia or conversely, bulimia, abdominal pain, occasionally quite intense, nausea and vomiting) and systemic disorders (malaises, dizziness, faintness).

Often the diagnosis is established when rings are found independently of the stools, or occasionally with them ; their flat, noodle-like appearance makes them easy to recognize.

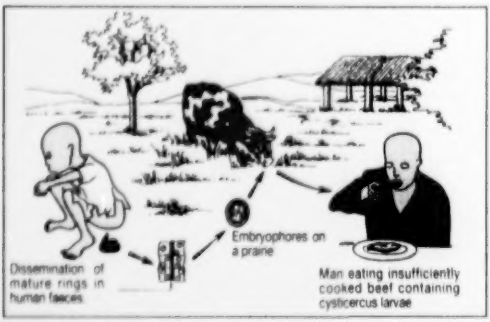
Embryophores on a praine
Dissemination of mature rings in human faeces
Man eating insufficiently cooked beef containing cysticercus larvae

Figure 6 : Dissemination of and contamination by Taenia Saginata.

Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Epidémiologie. Prophylaxie. Paris : les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

The eggs may be found in the stools, but are more often seen on the anal margin, where they have been deposited by a torn ring. They are evidenced by the Graham test, similar to the one performed to diagnose oxyuriasis. They are rounded, measure about 50 microns across, have a thick, radiated shell containing an embryo with three pairs of hooks (a hexacanth).

Hypereosinophilia is possible but not constant. When present it is usually moderate, except at the onset of infestation.

PORK TAPEWORM

Epidemiology

The pathogen is a flatworm (Taenia solium) similar to the above-mentioned, measuring 2 to 8 metres long, with a slightly different head (scolex) and rings. The mature rings, once shed, are unable to force their way through the anal sphincter, however, and are evacuated passively with the faeces.

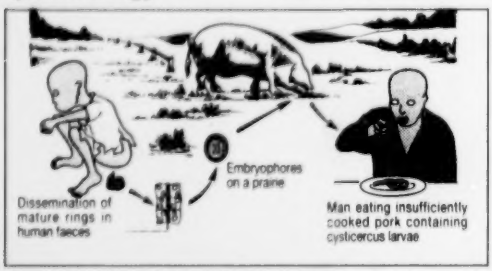
Embryophores on a praine
Dissemination of mature rings in human faeces
Man eating insufficiently cooked pork containing cysticercus larvae

Figure 7 : Dissemination of and contamination by Taenia Solium.

Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Epidémiologie. Prophylaxie. Paris : les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

The eggs contained in the rings reach the ground and may continue their cycle if they are ingested by a pig. The embryo then crosses the digestive wall and turns into a larva (a cysticercus) in the muscle tissue. Human infestation occurs when poorly cooked parasite-ridden pork meat is eaten. The cycle then continues in the same way as for the beef tapeworm (cf. figure 7).

Humans are the only final host. The intermediate hosts are swine (pigs, wild boar and wart hogs). The disease is cosmopolitan, but is mostly prevalent in South-east Asia and South America, and is absent in places where the consumption of pork meat is prohibited (Muslim countries).

Symptoms

The disease is often latent. It may produce signs of taeniasis identical to those seen with the beef tapeworm.

As opposed to the beef tapeworm, when food containing the eggs is eaten by humans, the eggs may develop into larvae, which are then encysted in the muscles or brain. Man is then an intermediate host, in this case. The corresponding disease is cysticercosis, and may be attended by convulsions : this is not a disease of the digestive system.

Diagnosis

It is based on the discovery of eggs during laboratory examination of faeces. These eggs are similar in appearance to those of the beef tapeworm. Hypereosinophilia may occur, but it is only severe at the start of the infestation.

INTESTINAL FLUKES

Epidemiology

Flukes are flatworms, the intermediate host for which are molluscs. Some live in the liver : they induce hepatic distomiasis, caused by the giant liver fluke, the Chinese fluke and the feline fluke (Opisthorchis felineus). Others live in the intestine, and are known as intestinal flukes. There are three main types of the latter : Fasciolopsis, Metagonimus and Heterophyes. They range in size from a few millimetres (Heterophyes) to several centimetres (Fasciolopsis).

The adult worms lay eggs which are evacuated with the stools. When in contact with water, the eggs mature and hatch a motile embryo which enters the species-specific intermediate host mollusc, where it undergoes its transformation. The larvae that result from this process (cercaria) enter the water and become encysted on aquatic plants (in the case of Fasciolopsis) or enter a fish (in the case of Metagonimus and Heterophyes). Human consumption occurs when this fish is eaten raw or when water soiled by these aquatic plants is consumed.

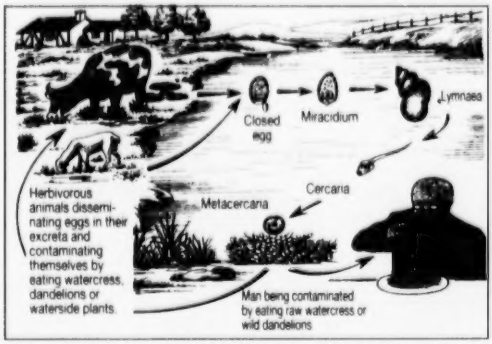
Closed egg
Miracidium
Lymnaea
Cercaria
Metacercaria
Herbivorous animals disseminating eggs in their excreta and contaminating themselves by eating watercress, dandelions or waterside plants.
Man being contaminated by eating raw watercress or wild dandelions

Figure 8 : Dissemination of and contamination by the giant liver fluke (Fasciola hepatica).

Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Epidémiologie. Prophylaxie. Paris : les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

These diseases are exceptional, and occur mostly in India and the Far East, with some cases in the Mediterranean basin (Heterophyes in Egypt). Humans are not the only final host, and many wild or domesticated animals are parasite reservoirs (cf. figure 8).

Symptoms

Infestation goes unnoticed as long as it is moderate, and the disease remains latent.

In case of massive infestation or repeated reinfestation, abdominal pain and diarrhoea are seen. Only rarely is there a clinical picture of malnutrition, with oedema and severe wasting.

Diagnosis

As a rule, the eggs of the species involved are easily observed when the stools are examined.

TRANS-CUTANEOUS TRANSMISSION

Surprisingly enough, certain intestinal parasites do not pass through the mouth to reach the digestive track. No digestive parasite is transmitted by an insect bite, but the larvae of some of those that live in water or mud may enter the body by crossing the skin.

ANCYLOSTOMES

The pathogen (Ancylostoma duodenale, or hookworm) is a pinkish-white roundworm measuring about 1.5 cm, the mouth of which is armed with hooks or cutting plates which enable it to "nibble" on the digestive mucosa.

Epidemiology

It lives in the small intestine (the jejunum), attached by its hooks to the mucosa, and causing it to bleed. It feeds on this blood : the bleeding persists unnoticed once the worm has changed place. Each worm causes the loss of 0.2 ml of blood a day. Often the parasites are extremely numerous : up to several thousand. Each worm may live for 4 to 5 years.

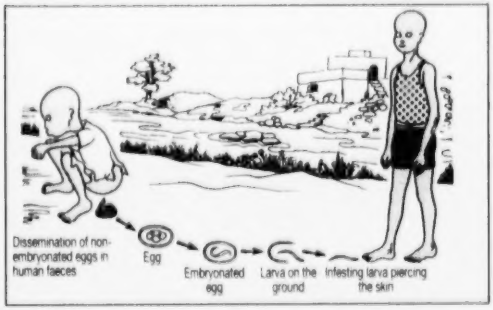

Figure 9 :Dissemination of and contamination by the ancylostome.

Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Epidémiologie. Prophylaxie. Paris : les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

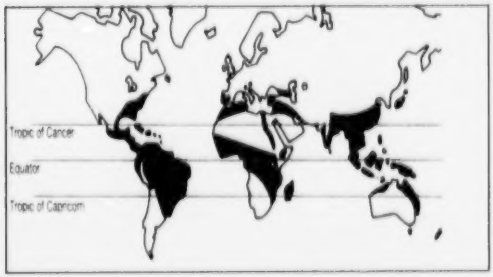

Figure 10 : Geography of ancylostomiasis.

Source : Gentilini M. et col. Maladies parasitaires. Paris : J.B. Bailliere, 1981.

The cycle is complex. The females lay eggs, which are eliminated in the stools. Outdoors (in wet places or mud), if the conditions are right, the egg matures and develops into a larva which becomes infesting after several transformations. When in contact with the skin (when people go barefoot, essentially), the larva crosses it and reaches the heart, through the bloodstream. Within 4 days it moves into the pulmonary arteries, the alveoli, bronchi and trachea, and when it reaches the pharyngolaryngeal level it then falls into the oesophagus. After several other transformations, the larva reaches the small intestine, and it attains adulthood there about forty days after contamination.

The disease exists in all hot, humid regions where people walk barefoot on wet or muddy ground fouled by human excreta. Humans are the only parasite reservoir : there is no intermediate host. The disease exists throughout intertropical Africa, Asia, America and Oceania. It is also present in temperate climates (in the Middle East, China and Japan) (cf. figures 9 and 10).

Symptoms

In tropical countries, the clinical signs - such as an eruption with itching when the larva crosses the skin, and coughing or pharyngitis when it reaches the meeting point of the respiratory and digestive tracks - are rarely seen.

Digestive signs are frequent when the worms arrive in the small intestine and establish themselves there. They involve diarrhoea with pain of the ulcer type (cramps, with "hunger pangs").

The main symptom is chronic anaemia. The constant bleeding caused by the worms, when they are numerous, along with other, associated diseases (iron and protein deficiencies, other digestive parasites, infectious diseases) may result in serious anaemia. Pallor is seen, exertion causes dyspnoea, tachycardia, various heart murmurs, low blood pressure, oedema, predominantly facial (of the eyelids) and of the lower limbs, softened, upturned, cupped nails, indicative of a secondary iron deficiency. There is no jaundice, however, nor enlarged spleen. Paradoxically, the anaemia seems to be well tolerated as a whole, although laboratory findings are spectacular (between 1 and 2 million blood corpuscles, with a sharp decrease in their volume). But it may account for growth retardation in a child, an at-risk pregnancy in an expectant mother, or sudden collapse in case of an intercurrent disease.

Diagnosis

Diagnosis can only be based on microscopic examination of the stools, showing the presence of characteristic eggs. By counting the eggs, the extent of the infestation may be estimated (parasite-caused anaemia is incurred when there are over 5,000 eggs per gramme of faeces). Occasionally anaemia is so severe that it prevents the worm from laying its eggs. In countries where it is pandemic, ancylostomiasis should be systematically suspected in case of chronic anaemia, and treatment given even if no eggs have been found. The difficulty and the risks presently involved in blood transfusion (of both HIV infection and viral hepatitis), make it preferable to destroy the worms and to combat deficiency (by giving iron and folates) rather than to immediately resort to transfusion, provided the anaemia is more or less well tolerated.

Hypereosinophilia is habitual at the start of the disease, 3 months after contamination at the most ; it declines gradually thereafter. A related parasite, Necator americanus, has a comparable cycle and the same consequences. Blood losses are slightly less severe, however. It may be distinguished from the true ancylostome by examining the eggs in the faeces.

ANGUILLULA

The pathogen is a roundworm (Strongyloides stercoralis) 2 mm long, living deeply imbedded in the mucosal villi of the upper portion of the intestine (duodenum). It is not a haematophage and feeds on food residues.

Epidemiology

The cycle is partially similar to that of the ancylostome. The adult worms lay eggs which hatch into larvae as soon as they cross into the intestine. The larvae are evacuated with the stools. If the outdoor environment is suitable (humid and sufficiently warm), they develop into infesting larvae which penetrate the skin through bare

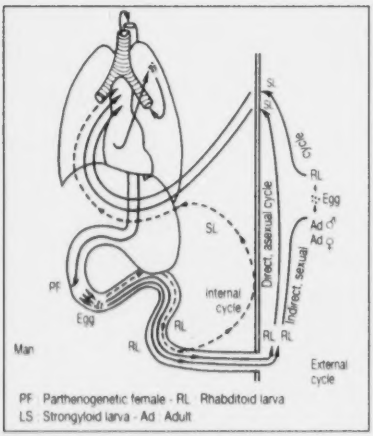

Figure 11 : Cycle of the anguillula.

Source : Gentilini M. et col. Maladies parasitaires. Paris : J.B. Bailliere, 1981.

feet, and arrive in the human body. From there on the larvae follow much the same path as the ancylostome larvae (moving through the circulation, heart, pulmonary alveoli, bronchi, pharyngolarynx and oesophagus). They reach adulthood in the duodenum about 2 to 3 weeks after contamination (cf. figure 11).

However, in a conducive external environment (very humid, over 20°C), the larvae evacuated in the stools may also develop into male and female larvae and proliferate. The resulting larvae become infesting, and resume the normal cycle once they have crossed the skin and entered the human body.

Auto-infestation is feasible, since the larvae that develop from the egg in the intestine may become infesting and cross the intestinal wall before they are evacuated with the stools ; in this case they resume the non-digestive phase of the cycle. This auto-infestation accounts for the extreme longevity of this disease (over 30 years) and for the usually high eosinophilia, corresponding to the frequently recurrent non-digestive larval phases.

The external conditions conducive to the transformation of larvae, an essential phase if they are to become infesting, are similar to those required by the ancylostome larvae. Contamination occurs under the same circumstances (bare feet, freshwater baths). The geographic distribution of the two parasites is practically the same, with the hot, humid intertropical regions predominantly affected (cf. figures 12 and 13).

Symptoms

In countries where it is endemic, the signs occurring when it pierces the skin and enters the respiratory track generally go unnoticed.

Figure 12 : Dissemination of and contamination by the anguillula.

Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Eoidémiologie. Prophylaxie. Paris : les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

Digestive signs corresponding to the adult, worm stage are mostly recurrent abdominal pain with alternating diarrhoea and constipation. When the parasite burden is heavy, anguillula may damage the digestive mucosa. This results in more or less severe malabsorption, and prevents balanced nourishment in the parasite-ridden individual, even in the absence of chronic diarrhoea.

Occasionally, a peculiar aspect of auto-infestation is clinically visible. When the larvae hatched from the eggs reach the infesting point in the rectal-anal region, they may cross the skin of the anal margin and be visible on the skin of the abdomen or perineum : they produce raised, prurigi-

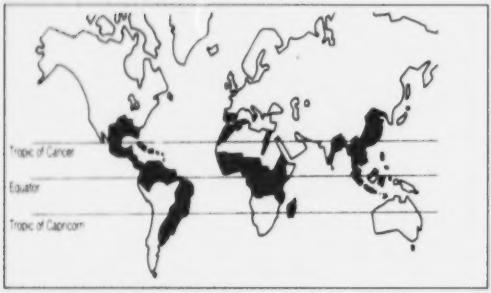

Figure 13 : Geography of anguilluliasis.
Source : Gentilini M. et col. Maladies parasitaires. Paris : J.B. Bailliere, 1981.

nous lines several centimetres long, which move extremely slowly (cutaneous larva migrans).

Exceptionally, in case of immune depression caused by a disease (AIDS) or medication (corticosteroids), the larvae spread considerably from their point of departure in the digestive track to every other organ (kidneys, liver, heart, brain) : this is known as malignant anguilluliasis, and culminates in death.

High (30 %), lasting hypereosinophilia, when accompanied by abdominal pain and defecation problems, is suggestive of this diagnosis.

Diagnosis

Laboratory examination of the stools yields confirmation. Eggs, which never leave the body, cannot be found, but larvae are present : the most appropriate techniques for detecting them are special Baermann extraction-concentration techniques.

SCHISTOSOMES

Schistosomes are a group of parasites the adult specimens of which live in the blood of the intestinal veins (the portal blood), and the symptoms generated by them depend on their preferential egg-laying location. Only intestinal bilharziasis caused by Schistosoma mansoni and rectal bilharziasis caused by Schistosoma intercalatum are digestive parasitoses.

Intestinal bilharziasis

The pathogen (S. mansoni) is a worm 1 to 2 centimetres long, living in the veins that carry blood from the intestine to the liver. The female lays her eggs on the walls of the digestive track. Digestive symptoms are produced by the inflammatory reactions caused by the eggs, whereas adult worms do not produce any clinically identifiable sign.

Some of the eggs remain in the intestinal wall, others cross over into the intestinal cavity and are evacuated with the stools. The eggs are then unable to pursue their evolution unless the embryo that is hatched reaches fresh water and enters an intermediate host mollusc. It leaves the latter one month later in the form of an infesting larva (furcocercaria), which may then enter the human body by penetrating the skin. The larva then follows a complex circuit through the intestinal veins. The first eggs will be seen in the stools about 3 months after contamination.

Intestinal bilharziasis is found around freshwater ponds in hot, humid areas, such as the coastal regions of South and Central America, intertropical Africa and the Arabian peninsula. Man is the main parasite reservoir, but some wild mammals such as monkeys and rodents may also be reservoirs.

Occasionally an itchy rash lasting a few hours may occur when the parasite penetrates the skin. Fever sometimes occurs during the larval migration phase.

The main signs are digestive, and accompany egg-laying. There is lingering diarrhoea sometimes suggestive of dysentery (with blood and mucus in the faeces, or simply ordinary diarrhoea.

Some of the eggs remaining in the portal veins are carried to the liver, where they may induce portal hypertension about ten years later. The signs of this complication, rarely seen in Africa, include an enlarged liver and spleen, and formidable digestive bleeding.

Hypereosinophilia is present, and is acute mostly during the larval migration phase.

The diagnosis involves microscopic examination of faeces, and is positive when the characteristic oval eggs, measuring 140 microns by 60, with their peculiar lateral spur-like outgrowth, are found.

Rectal bilharziasis

The pathogen is named S. intercalatum. It has very much the same cycle as S. mansoni, but the intermediate host is a different mollusc. Contamination occurs in the same ways.

This bilharziasis is found only in the western part of central Africa (Cameroon, Gabon, Congo, 2aïre).

The signs include rectitis (inflammation of the rectum) with mucosanguineous diarrhoea, painful defecation and prolapse.

The diagnosis involves the laboratory examination of faeces, which may uncover eggs 200 microns long with a spur-like terminal appendix, and which Ziehl's technique shows to be acid-fast.

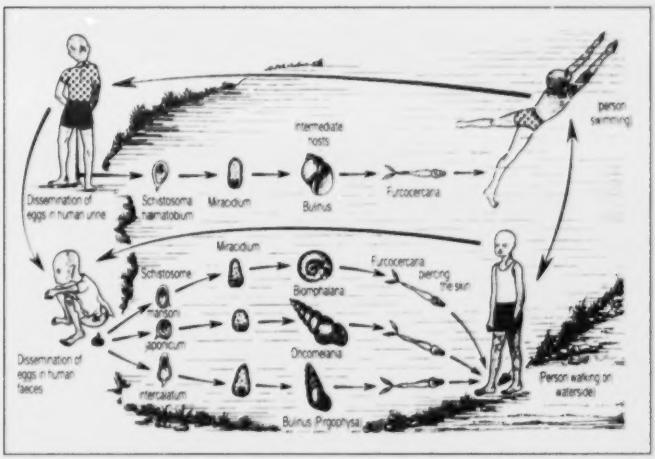

Figure 14 : Dissemination of and contamination by the schistosome.

Source : Larivière M. Parasitologie tropicale. Les grandes endémies. Epidémiologie. Prophylaxie. Paris : les éditions Foucher, 1978 ; 3 (Les professions médicales et sociales).

CONTROLLING INTESTINAL PARASITES

The fight against intestinal parasites is based on the use of active drugs, the main features and indications of which must be learned, and the application of preventive measures, the most important of which, aside from general sanitation, is education for health, with all of the difficulties attendant on its implementation.

TREATMENT

Many of the drugs used are active on several intestinal parasites. In tropical countries, these are mostly prescribed in cases of multi-parasitism, which are quite frequent. There are two broad categories of major drugs : the nitroimidazoles and the benzimidazoles.

THE NITROIMIDAZOLE FAMILY

These are active on a number of intestinal protozoans, but also on anaerobic germs.

Metronidazole

Metronidazole is a basic drug used to combat intestinal protozoans and anaerobic bacteria. It is taken orally and is almost entirely absorbed in the intestine. Its serum half-life is about 8 hours. Some of it is then evacuated into the intestine : it is therefore in contact with "minuta" amoebae in the bloodstream, and with the cysts in the gut lumen, but most of it is evacuated in the urine.

The main indications are :

- acute amoebiasis : the required dose is 30 mg/kg/day in 3 divided doses at the end of meals for 8 to 10 days. The intravenous route (with 3 injections a day) is prescribed exceptionally, and only when oral intake is not feasible. Some specialists recommend that its action be completed by a contact antiamoebic, to achieve greater efficiency in the minuta forms and cysts ;

- giardiasis : the recommended dose is 15 mg/kg/day for 5 to 8 days.

This drug is well tolerated, on the whole. It may cause headaches, digestive pain, a "metallic" taste in the mouth and dark-coloured urine. Complications (including stomatitis, peripheral neurological conditions, temporary drop in white blood corpuscles) are exceptional. There may be some interaction with other drugs : its presence enhances the action of anticoagulants and causes poor toleration of alcohol. It is contraindicated in early pregnancy, and lactating mothers are advised to cease nursing during the treatment.

It comes in 200 and 500 mg tablets, an injectable 500 mg solution in 100 ml bottles and a 200 mg for 5 ml benzoate solution. Tablets and solution must be kept in sealed containers, in a dark place.

The new nitroimidazoles

The new nitroimidazoles are valuable because their long-lasting action makes shorter prescriptions possible, but they are much more costly.

Tinidazole

Tinidazole (Fasigyn) has a 12-hour half-life. It is as active on pathogenic amoebae (E. h. histolytica) as metronidazole. Adverse reactions are exceptional and minor (nausea, abdominal pain, dizziness). 60 mg/kg/day for 3 days suffice in intestinal amoebiasis. In giardiasis, a single dose of 50 mg/kg is sufficient.

Ornidazole

Ornidazole (Tiberal) has a 14-hour half-life. It may be administered orally or intravenously (in case of septicaemia with anaerobic germs). Adverse reactions are the same as with the previous drug. In amoebiasis, a dose of 60 mg/kg/day is prescribed for 7 days and in giardiasis the prescribed dose is 50 mg/kg/day for 5 days.

Secnidazole

Secnidazole (Flagentyl) is more active in amoebiasis than metronidazole : a single dose of 50 mg/kg is curative, and eliminates both haematophages and minuta forms.

BENZIMIDAZOLES

These are active on several species of intestinal worms.

Mebendazole

Mebendazole prevents the worms from feeding, and thus causes their destruction. Following oral intake, less than 10 % of the dose passes into the bloodstream, while over 90 % remains in the gut lumen, in contact with the parasites, and then is evacuated in the stools. The small amount that is absorbed is destroyed in the liver.

It is active on several intestinal worms : the oxyuris, ascaris, trichuris and ancylostome. It is widely used in community eradication programmes.

It must be taken between meals :

- for oxyuriasis : a single dose of 100 mg irrespective of age, repeated once, 15 days later ;

- for ascariasis : a single dose of 300 mg ;

- for ancylostomiasis and trichuriasis : 100 mg in the morning and evening for 3 consecutive days, repeated if needed 3 to 4 weeks later. A single 600 mg dose is effective in ancylostomiasis.

This drug is well tolerated, and rarely causes digestive disorders. It is contraindicated during the first three months of pregnancy since the small amount that is absorbed may affect the embryo adversely. It exists in chewable, 100 mg tablet form and as a 100 mg for 5 ml oral solution.

Flubendazole

Flubendazole (Fluvermal) is quite similar in composition. It exists in 100 mg tablet form, and as a syrup, with 100 mg per measuring spoon. Digestive uptake is even lower than for mebendazole. There are no adverse reactions. Its action and indications are the same as for mebendazole, but it is more effective than the latter against trichuris. There are no contraindications for its use, even in case of pregnancy.

Thiabendazole

Thiabendazole (Mintezol) blocks the cell functioning of several worms, but it does produce adverse reactions, which may be serious. Following oral intake, uptake occurs rapidly. Its blood concentration peaks within one hour. It is modified within the liver, and evacuated in the urine.

The main indication is anguilluliasis, for which it is the most effective drug available. A single dose of 50 mg/kg or 3 consecutive daily doses of 25 mg/kg are given, preferably after a meal.

The following adverse reactions may be observed : dizziness, painful digestion, somnolence, headaches and prurit. More rarely, there may be visual and auditory disorders, hyper-irritability and low blood pressure. Allergy is possible, with fever, vasomotor flushes, shivering, conjunctivitis, Quincke's oedema and polymorphic erythema. Last, there may be haematuria, with strong-smelling urine. It is contraindicated during the first three months of pregnancy.

It comes in chewable 500 mg tablets, which must be stored in sealed containers.

Albendazole

Albendazole (Zental) acts similarly to mebendazole but is active against a larger range of worms. Its uptake from the digestive track is better than for mebendazole. Serum half-life is 8 hours. Most of the drug is evacuated in the urine, following modification in the liver.

It is active against most intestinal roundworms, including trichina, and is partially effective against taenias, at a single dose of 8 mg/kg. Its use has been suggested in case of hydatidosis (the larval form of a taenia found in dogs, and producing cysts in the lungs and liver), at a dose of 10 to 15 mg/kg/day in 3 daily divided doses, for one month, repeated 3 or 4 times at 2-week intervals.

It may cause digestive disorders and headaches.

The 200 and 400 mg chewable tablets must be stored in sealed containers.

OTHER DRUGS

Piperazine

Piperazine has been well-known for many years ; it seems to act on ascaris by blocking its muscles. When taken orally, its uptake through the digestive track is satisfactory, but its serum half-life is highly variable. It is mostly evacuated in the urine.

This is the conventional drug used to combat ascariasis, at the dose of 75 mg/kg in children over age 2 years (without exceeding 3.5 g) and 50 mg/kg in children under age 2. Usually this dose may be given all at once, between meals, but some specialists recommend that it be divided and given on 2 consecutive days. In case of oxyuriasis, the same dose is given on 7 consecutive days.

The drug may cause digestive pain, and more exceptionally, reactions of an allergic nature (fever, painful joints, itchy rashes), requiring interruption of the treatment. Dizziness or prickling feelings in the limbs may be experienced. An overdose may cause convulsions, temporary paralysis of the limbs and depressed breathing. Epilepsy constitutes a contraindication.

Drug forms include 500 mg piperazine hydrate tablets and a 500 mg per 5 ml oral solution. They must be stored in a dark place, in sealed containers.

Pyrantel

Pyrantel also acts by paralysing the worms, which are then seen in the faeces, but the mechanism through which it acts differs from that of piperazine. Its uptake from the digestive track is minor, and most of it is evacuated in the stools.

This drug is active in oxyuriasis, ascariasis and ancylostomiasis. A single dose of 10 mg/kg is generally sufficient in all three parasitoses. However, treatment should be repeated 2 weeks later in case of oxyuriasis, and the same dose must be given daily for three consecutive days in case of massive infestation with ancylostomes. Some mass treatment programmes prescribe the quarterly administration of 2.5 mg/kg, to reduce the prevalence of ascariasis.

On the whole, this drug is well tolerated ; only a few slight digestive disorders are occasionally seen. There is no contraindication, but Pyrantel and piperazine should not be given simultaneously, since their effects are mutually cancelled out.

The drug comes in 250 mg chewable tablets and a 50 mg/ml oral solution. It must be stored in sealed bottles and protected from light.

Niclosamide

Niclosamide is the main active taeniacide : it destroys the worms in the intestine. Since the dead worms are not necessarily visible in the stools, there is no need to look for them as proof of the efficacy of the drug. There is almost no uptake from the intestine, which explains why it is usually well tolerated.

This is currently the reference drug for combating tapeworms. The tablets must be chewed slowly and thoroughly, then swallowed with a little water, at a dose of 1 g for a weight of 10 to 35 kg, 0.5 g for a weight under 10 kg and 2 g beyond 35 kg. Auto-infestation with Hymenolepis nana requires that the treatment be repeated on 7 consecutive days.

There is no contraindication. The drug occasionally induces minor digestive disorders. Laxatives or purges should not be administered routinely with it, and are only justified in case of constipation.

The drug is marketed in the form of 500 mg chewable tablets, requiring storage in a dark place.

Anti-schistosomal agents

The old drugs (niridazole, hycanthone) have now been replaced by more efficient, less toxic substances.

Praziquantel

Praziquantel is highly active in combating schistosomes, flukes and certain taenias, but its high price limits its use. Its uptake from the digestive track is quite good, after which it is transformed and eliminated in the urine. When in contact with it, worms contract and loose their hold. They are then destroyed in the bloodstream (in the case of schistosomes) or in the intestine (flukes, taenias).

The usual indications are :

- for bilharziasis : a single 40 to 60 mg/kg dose. It is slightly less active on S. mansoni and S. intercalatum than on S. haematobium ;

- for taenias, and especially for Hymenolepis, for which the conventional treatment using niclosamide is less effective, a single 25 mg/kg dose ;

- for intestinal flukes : a single 25 mg/kg dose.

Tolerance of this drug is excellent. Exceptionally, abdominal discomfort, dizziness or headache may be experienced. There is no contraindication. It comes in 150 and 600 mg tablets, requiring storage in a dark place.

Oxamniquine

Oxamniquine is less costly than praziquantel ; it is effective against S. mansoni but not in the other bilharziases. Its uptake from the digestive track is satisfactory ; it enters the blood, is transformed and eliminated in the urine.

The recommended dose in intestinal bilharziasis is 20 mg/kg (15 mg/kg beyond a body weight of 30 kg) in two divided doses in western Africa, South America and the Caribbean. In central and eastern Africa and in Arabia, 30 mg/kg in two divided doses is necessary.

Dizziness occurs in about one third of cases. Headaches, vomiting and diarrhoea are infrequent. In a few exceptional cases, hallucinations and convulsions have been documented. It is contraindicated in case of epilepsy.

Drug forms are 250 mg capsules and a 250 mg/5 ml syrup. They must be kept in closed containers, and protected from light.

INDICATIONS

PROTOZOANS

Amoebiasis

Symptom-free carriers

In regions where amoebiasis is not endemic, children who have cysts or E. h. minuta forms in their stools should be treated, even in the absence of clinical signs. A contact amoebicide (which is directly active in the gut lumen) such as diloxanide, clefimide, etofamide or teclozan is sufficient. Endemicity makes this treatment useless, since its efficacy is illusory.

Patients

The reference treatment for acute amoebiasis is metronidazole. Some workers add a contact amoebicide. The other nitroimidazoles are approximately as effective, and the treatment is shorter but their cost is considerably higher. Dehydroemetine is no longer recommended for the treatment of acute intestinal amoebiasis.

Giardiasis

The basic treatment in giardiasis is metronidazole and the other nitroimidazoles, when available. However, given the extreme frequency of transmission of this parasitosis, it is essential that all individuals living under a same roof and children in collective settings (nurseries, schools, etc.) be treated simultaneously, to avoid reinfestation.

Cryptosporidiasis

There is no effective treatment for cryptosporidium. Metronidazole is ineffectual. Only paromomycin seems to have a slight impact. Aside from cases of immunocompromise, drug treatments are useless.

ROUNDWORMS

Oxyuriasis

Several drugs combat oxyuriasis effectively. They are mebendazole, flubendazole, albendazole, piperazine and pyrantel. A single

dose is sufficient for most of these, with the exception of piperazine, which must be given for 7 days.

Since this is a highly transmissible parasitosis, the simultaneous treatment of all individuals in contact with a child who is known to be affected is recommended. A second treatment round two weeks after the first one aims at destroying the worms hatched from the eggs present during the first cure.

Ascariasis

At the individual level, a single treatment with pyrantel, piperazine or one of the benzimidazoles is effective against ascariasis. In case of pandemicity, mass treatment of the entire population seems justifiable when over half of the population has parasites. Another suggestion is the selective treatment of children every 4 to 6 months. This approach can be effective in the long term only if it is viewed as a complement to sanitation measures and to effective education for health.

Ancylostomiasis

Anti-ancylostomiasis treatment with mebendazole, flubendazole, albendazole or pyrantel is effective on the individual level. In case of anaemia, a 3-month course of supplemental iron in the form of a ferrous salt is required. In case of pandemicity, systematic treatment of children and pregnant women using an inexpensive drug given in a single dose (pyrantel) is recommended.

Anguilluliasis

The most effective drug for combating anguilluliasis is thiabendazole. However, albendazole, given on 3 consecutive days, is also a possibility : tolerance is better, and it is effective both on the anguillula and on other worms. The other common anthelmints (mebendazole, pyrantel, piperazine) are not recommended.

Trichuriasis

Trichuriasis must be treated if clinical signs are present or if examination of the stools reveals massive infestation. Albendazole is more effective than mebendazole or flubendazole.

Trichinosis

Some of the available drugs effectively combat adult trichina worms in the digestive track (mebendazole, flubendazole, thiabendazole, etc.). However, symptoms are mostly connected with the migration and intramuscular encystment of the larvae. No drug has proved effective against these larvae. Albendazole, thiabendazole and diethylcarbamazine (Notezine, an antifilarial agent) seem to yield the best results, at a dose of 6 mg/kg/day for 12 days.

FLATWORMS

Tapeworms

Niclosamide is the drug most widely used to combat tapeworms. It is active on the different taenias that affect children, but a 7-day course of treatment is required when Hymenolepis nana is involved. For the latter, praziquantel is more completely and more rapidly effective, but it is not readily available and more expensive.

Intestinal distomiasis

Intestinal flukes respond to a number of anthelmints, and especially to niclosamide, at the same dose as is used for the beef tapeworm. Praziquantel is effective with a single dose of 25 mg/kg.

Intestinal bilharziasis

Praziquantel is effective in all types of human bilharziasis. S. mansoni and S. intercalatum are combated by a single dose or two divided doses of 40 mg/kg on the same day. Oxamniquine is

only effective against S. mansoni. Oxamniquine and praziquantel, both of which require only a single dose, make mass chemotherapy feasible : the restrictions are their cost and the possible existence of an animal reservoir for S. mansoni.

PREVENTIVE MEASURES

The prevention of diseases caused by intestinal parasites must be grounded in epidemiological reasoning, so as to determine where the epidemiological chain or cycle may be broken : if this cycle is interrupted completely at any one point, the transmission and spread of the parasitosis is stopped. Diagrammatically, the various epidemiological chains may be pictured as follows.

Parasite reservoir			Contaminating factor
1. HUMAN	⟶	stools	Drink Food Contact with water (bathing, mud)
2. ANIMAL	⟶	muscles	Food

The first of these two epidemiological chains is by far the main type of transmission, and should be given top priority.

There are different levels at which the chain may be broken : at the human level, through the treatment of parasite-ridden individuals and in stools, by implementing measures preventing the spreading of infesting agents through faecal matter. Action may aim at food and drink, through sanitation measures for preventing the intake of infested substances, and last, through analysis of contacts with water when contamination is transcutaneous.

At each point in the chain, action may be individual and/or collective.

At the collective level, we find mass treatment, sanitation measures, with the installation and maintenance of efficient toilet facilities, the organization of sewage disposal and also of a drinking water supply. The elimination of infested muddy water-places and the destruction of the molluscs in freshwater expanses may also be considered.

At the individual level, there is the treatment of patients, personal hygiene, with special emphasis on clean hands, the need to wear shoes and the avoidance of bathing in fresh water.

At both the individual and collective levels, education for health aims at modifying all of the attitudes conducive to the persistence of the epidemiological chain.

PUBLIC HEALTH ACTION

Digestive parasitoses are extremely frequent. Most prevail essentially in tropical settings. The problem, then, is one of their overall repercussions, so as to determine which comprehensive measures are most relevant, and what form they should take.

There is considerable evidence that intestinal parasitosis affects children's development. In countries where the ascaris, trichuris and ancylostome are highly endemic, growth retardation, poor attendance at school and less satisfactory achievements are found in schoolchildren. Because of the correlation between education and productivity, it is probable that these pandemic diseases generate substantial economic losses. However, the clinical expression of these parasitoses is highly variable, and often quite minor. For a given intensity of infestation, some children experience discomfort whereas others will not suffer from any disorder. This partially accounts for the inadequacy of epidemiological data, more of which would be required to determine the consequences of these parasitoses on the quality of life of different communities.

At the collective level, the question is which of the theoretically possible actions are truly feasible ? Often, the investment required to supply clean water and build proper toilet facilities is considered to be excessive, beyond the financial capacities of a programme aimed specifically at controlling a single disease. Drug distribution, with the organization of a special infrastructure aimed at controlling intestinal parasitoses only is also too costly.

When the problem is considered, the option usually chosen is the treatment of at-risk population groups, and of children in particular. Such targeted mass treatment campaigns must be preceded by surveys aimed at identifying at-risk groups, and establishing a reference on which to base future evaluation. Questionnaires and laboratory examinations of stools in schoolchildren are the usual methods, particularly since the school system disposes of the most effective means of distributing drugs. Outside of schools, there are other possible options, but which encounter many obstacles : the screening and treatment strategy may be integrated in the existing health agencies, but the cost of equipment and of training personnel is high. Some attempts have confined treatment to cases detected on the basis of clinical symptoms. In many instances, however, children are unaware that they are suffering from a parasitic disease, even if it affects nutritional status or achievement at school. Furthermore, the usual signs (abdominal pain, diarrhoea) are not specific and remain commonplace : they may be caused by a wide variety of ailments.

One might imagine that strategies depend on economics only. However, families are often prepared to spend large sums of money to purchase drugs that combat intestinal worms. This points to growing awareness of the problem ; it should be possible to capitalize on this to promote education for health.

EDUCATION FOR HEALTH

Intestinal parasitoses, which affect one fourth of the global population, are caused by poverty, lack of hygiene, absence of clean water and of toilet facilities, and some bad habits. Even if the prevalence of these diseases, which seriously impair the health of the population, could be reduced by raising standards of living and by a large-scale sanitation policy, this would require finances that are not available - by far - in the developing countries today.

Furthermore, many failures in field work have led to acknowledgement that the construction of latrines does not mean that they will be used in a sufficiently hygienic way, and that the introduction of a clean water supply, by installing pumps, for instance, does not necessarily imply that villagers will forsake their wells and ponds.

If such actions, which are essential for sanitation, are to achieve their goal, which is the improvement of the health status of the population, they must be preceded and/or accompanied by increased awareness among community leaders at all levels. All must understand the harmful effects of the current situation and the benefits to be derived from a radical change in everyone's habits. This is the objective of education for health.

Intestinal parasitoses are a difficult subject

Intestinal parasitoses are not easy to discuss within education for health programmes : since they are extremely frequent, people tend to view them as quite commonplace, and not really as diseases. Indeed, it is estimated that one fourth of the global population is infested with ascaris and ancylostome worms, with ancylostomes affecting 900 million individuals and schistosomes 300 millions, while in some communities everyone or nearly everyone suffers from polyparasitism. Furthermore, clinical signs are often minor, as in ascariasis, and people are not frightened when they find worms in their stools, since this is extremely frequent. Other parasitoses such as anguilluliasis have much more serious clinical repercussions, but which are rarely attributed to their true cause.

"Having worms" often seems to be a normal fact of life, then, something like puberty, perhaps. To the point where some people may not be sure that a child can develop fully without parasites.

In addition, this subject cannot be broached without some theoretical knowledge, which people who are unaccustomed to science teaching may find too austere. The first task of an education for health programme is to provide simple, but scientifically accurate popularized knowledge, so that people will get to know these fa-miliar but poorly known parasites, before explaining how to protect oneself against them.

Planning is an essential phase in any education for health programme designed to combat intestinal parasitoses. A true "plan for health action" must be prepared, in which learning of new facts and skills will be reinforced and extended by individual action, both personal and within a group in the community. This requires the choice of an appropriate approach, the definition of the contents of the messages to be transmitted and of the objectives to be achieved, the definition of the methods to be used, the collecting of the necessary educational material and last, the inclusion of an evaluation phase at each level of this plan.

An appropriate approach : "Child to Child"

The purpose of this educational action is not to offer advice such as "wash your hands after defecating and before meals", "use the latrines", "drink clean water". Its objectives are to explain why these parasites are dangerous, to describe the disorders they may

cause, especially in small children, to provide accurate scientific information on their cycle and how they are transmitted to humans, before explaining how to protect oneself against them.

For this reason, schools are viewed as the best place to offer this type of education for health, although the other, usual media (health workers, posters, radio, etc.) are not excluded. By using the Child to Child approach, the children who learn then transmit the message to those around them, and become truly active health messengers for their family and community.

Child to Child is an original approach to education for health applied to school-age children. It was developed fifteen years ago for International Children's Year, and is now used in more than 70 countries. It makes children feel responsible for their own health and for the health of their younger brothers and sisters, their family as a whole, and the community. It helps them to establish connections between what they learn and experience at school and their learning and living experiences at home and in their village or neighbourhood. It uses active teaching methods in which learning takes place through the dynamics of investigations, group work and play, and is put into practice, so as to spread messages to others, and improve living conditions at school, at home and in the community.

From the planning stage on, the promoter of the project, who is usually a health official at the national, regional or local level or a member of an association, should involve the people in charge of education (teachers, school principals, inspectors, educational counsellors). The agreement and cooperation of the administrative authorities, parents, and other actors in development (such as rural facilitators, hydraulic agents, etc.) should also be obtained from the start.

Contents of the messages and objectives to be achieved

For clarity's sake, let us take the example of a project that is confined to one or several rural schools, and devoted to a specific topic, the ascaris. Actually, an education for health project of this type would include other parasitoses, the control of diarrhoeal diseases, environmental sanitation and drinking water, and also breast-feeding, immunization, etc.

Information

Most school science programmes generally include the study of the main human intestinal parasites. With the Child to Child approach, this subject is taught in an interdisciplinary way, both in science classes and in language, arithmetic, morals, etc., so that the subject is broached in a different but complementary way each time. This method may be used even with extremely young pupils, provided the contents are adjusted to their age and educational level ; collaboration between the health and education sectors is extremely valuable, then.

Objectives

objectives depend on the age of the children involved in the project, but also on the local situation. Each school or group of schools must develop its own plan of action, specifying :

- what knowledge and skills the children should acquire at each level. For instance, ability to describe the ascaris, how many eggs an ascaris lays each day, on the average, how people are infested with ascaris eggs (the cycle), how can people rid themselves of the ascaris (by avoiding the dissemination of ascaris eggs on the ground and in food and water) ;

- behaviour to be learned in order to put what they have learned into practice : at school for example, use the latrines, wash one's hands after defecating and before meals, make sure that the younger children do the same ; at home, teach younger siblings the basic motions of hygiene, and in the community, spread the message through songs, plays, etc. ;

- methods for evaluation, to measure the results of this action, changes in the attitudes and behaviour of children and teachers, the repercussions of this action at school and in homes. Teachers and children themselves should participate in this evaluation.

Child to Child : the method

The introduction of the Child to Child method in schools induces major changes in the way subjects are taught and learned, since the idea is no longer to study to "get better grades", or because it will be useful "later". Students work together to protect their own health and the health of others, and what they learn in the classroom is immediately applied to everyday life at school, at home, in the village or neighbourhood.

The Child to Child method is time-consuming, but the notions that the children gradually accumulate are put into practice continually, and are assimilated for a lifetime.

Four successive phases are involved in the introduction of Child to Child activities.

First phase

• Recognition of the importance of the subject for everyone's health, through understanding of the frequency of ascaris in the community, for instance.

• Understanding of the key message : ascaris are present because of poor sanitation.

Second phase

• Deeper understanding of the subject, through a survey, for instance : who in our class or of the people around us has ascaris worms ? How are they treated ?

• Discuss the results of this survey : what traditional remedies are effective ? What treatment does the health worker use ?

• Learn how to avoid infestation : by using the latrines, and washing one's hands after defecation.

Third phase

• Plan individual and collective action at school, at home and in the village.

• Act, for instance by setting up a health committee whose duties include making sure the latrines are kept clean in homes, teaching small children to wash their hands after defecating, and in the village, transmitting the message through songs and dances.

Fourth phase

• Evaluate the actions undertaken, how they were accepted, the improvements achieved.

• Draw up a new plan of action, to go further.

Educational material

Before undertaking any action, it is important to collect all available educational material (science textbook, drawings, etc.). Cooperation with the local health worker is essential here, since he or she may not only provide teachers with any scientific information they are lacking, but may also obtain material such as educational pamphlets and posters, and perhaps even some ascaris worms in formol.

The Child to Child bureau (1) also publishes educational material designed for teachers and schoolchildren, and which may be used as resource material, and as an idea box (cf. Further reading).

One of the key objectives of Child to Child is to make use of children's imagination and creativity to communicate health messages to other children and to those around them. This implies recourse to new educational media, including story-telling, which has always had two functions - amusement and education - in traditional cultures. In places where culture is still transmitted orally, story-telling continues to play an important role. It is a playful and instructive way of conveying to both children and adults what their society views as practical morals and proper conduct for harmonious social life.

The idea of using this educational tool in schools is not a new one, and modern educational theory has rediscovered it and rehabilitated its underlying principles : to capture children's interest one must amuse them, awaken their curiosity and stimulate their imagination. But there were no stories focusing on health themes, and communicating not only social and moral values, as traditional tales do, but also messages and advice about health. "Child to Child" stories are original texts, structured along the same lines as traditional folk tales, but whose purpose is to communicate essential information about a high priority health subject in a way that is amusing rather than didactic. They are published as illustrated readers, and are accompanied by an educational handbook for teachers and educators.

At school and even outside of school, these stories may be used as facilitating material for reading, oral expression, vocabulary enrichment and real learning through pleasurable activities. Next, the child (or a group of children who may turn the tale into a play) will be all the more eager to spread the story and its health message, since this gives them importance in the eyes of others.

(1) The child to Child Trust. The Institute of Education. 20 Bedford Way. London WC1HOAL. United Kingdom.

Here is one episode of a story about the ascaris, taken from a Child to Child reader on parasitic worms, entitled "The young man and the dragon" (Dr. Yvon Moren, EDICEF, 1993). The story follows a relatively stereotyped outline, in which a hero must overcome a series of difficulties in order to win the hand of the princess. It is broken down into three parts dealing with different parasites : the Guinea worm, ascaris and ancylostome. In each part, the sequences are the same : the hero's quest, the announcement of the ordeal, in the form of a riddle, the help of the mediator (the kind old lady, somewhat of a fairy godmother), the hero's victory and his reward, put off twice and attained at last.

Tales and characters of this type may be found everywhere. There are no serious obstacles to transcribing this one to fit the culture of any northern or southern country. The same outline may of course be used to broach the study of other intestinal parasites.

The king, the young man and the food-robbers

Once upon a time, there was a king who had a daughter, as beautiful as a calabash full of gold. The king said : "I will give my daughter's hand to the man who succeeds in ridding us of the gangs of robbers who seize our children's food. He will not have to pay any dowry."

A young man heard about the princess. He mounted his horse, and set out. He was dressed in a beautiful boubou, and wore a great sword. As he neared the village, he met an old lady, who was gathering wood. He picked up the bundle of wood, which was very heavy, and carried it home for her, on his shoulder. When they arrived, the old lady thanked him, and asked : "Where are you going, with your horse, grandson ?" He answered : "I have heard about the king's daughter. She is very beautiful. The king will give her to the man who kills the food robbers." And he raised his sword to the sky.

The old lady said : "To reward you, I will help you. But put your sword away. It is useless against those robbers. Listen closely : these robbers are completely naked, they do not have any legs, and they are hidden..." The young man thought she was making fun of him, and he was about to be angry, when the old lady continued her story : "they are long, pink worms, the size of earthworms, who live in gangs in children's belly. It is there, in their intestine, that they appropriate part of the food for their own use. The ascaris worms - that is the name of those villains - are very greedy. They eat the equivalent of ten large bags of rice a year in our village. And not only do they rob children, but they make them sick."

And she added : "The ascaris worms lay eggs, millions of tiny eggs. The eggs do not stay in the belly. The intestine expells them, with the faeces. After that, you find them everywhere, on the ground, in

the water, on vegetables, on dirty hands, on food. They are so tiny - a single fly can carry hundreds of them - that people swallow them without ever noticing them. Now, grandson, you know what you must do."

The young man went on along the road to the village. He was very handsome to see, riding on his horse. He told the king :

- "I have come to chase the robbers who take children's food."

- "Are you a great medicine man ?"

The young man did not answer.

- "I agree, said the king. If you do away with the robbers, you will have my daughter. Tomorrow, I will give you an escort of one hundred followers, to help you. Night is falling, tether your horse and come rest in my hut."

When the rooster crowed, the young man was given a bowl of sweet millet. He ate it, then went to each of the village concessions, followed by one hundred helpers. In each concession, behind the huts, but also in the gardens surrounding the village, he asked them to dig a deep hole in the ground.

He said : "These will be the latrines, for young and old. They will be the tomb of all those big worms that steal the children's food. Their eggs will remain there and die there, and will no longer infest children." And he left. When he returned, there were no longer any ascaris worms : the race had disappeared. The young man then asked the king to give him his reward, but the king was already sorry he had made that promise. And other enemies were threatening his kingdom. "To win my daughter, you must accomplish another feat..."

SOME EXAMPLES OF ACTIVITIES

Making a survey in a village

A survey can be made of mothers.

Do their children have worms ? What is the name of these worms ? In their opinion, what causes them ? Do they think that it is normal to have worms, and for all children to have them ? Do they know of any medication against worms ?

The questionnaire should be drawn up in the classroom, under the teacher's supervision. This activity will teach the children to present the results of a survey, and to interpret them.

A visit with the health worker

The health worker will be informed of this survey beforehand by the people in charge of the project, and a small group of children should go to the health centre, armed with a few questions prepared in advance : for example, how many of the village's children have intestinal parasites, what action is undertaken (treatment using anthelmints, activities aimed at improving sanitation, such as the construction of latrines in homes and schools, etc., educational and informational activities), what difficulties are encountered ?

The group then reports on its survey to the rest of the class. If the health worker has the time, he or she may come to the school, and discuss the subject with the teacher, the children and possibly the parents.

Interdisciplinary action

Education for health may be a part of various school activities. For instance, in science classes the children may examine an ascaris, or at least a common earthworm (lumbric). Language classes may use the story "the king, the young man and the food robbers" for lessons in reading, vocabulary and oral and written expression.

In arithmetic lessons, it is easy to construct examples based on education for health - the ascaris, in this case. Take multiplication and division exercises, for example. In a village of 1,000 inhabitants, one person out of two is parasited with 20 ascaris worms. If 20 of these worms eat the equivalent of three grammes of rice a day, how many kilos of rice (or their equivalent) do they steal from the village population in a year's time ?

In teaching numbers to the tenth power, the following exercise may be given : a child has 25 ascaris worms in his belly, each of which lays 200,000 eggs a day ; he defecates outdoors, and not in the latrines. How many ascaris eggs has he put on the ground in one year ?

Volumes may be taught in a similar way : a pit 4 metres deep must be dug for latrines, with an opening measuring 1.5 metres on each side. If a villager can remove one cubic metre of earth a day, how many days will it take him to dig this pit ?

Establishing a plan of action

What will be done, individually or in a group, at school, at home, in the village ? Make a list of people who may be helpful, of the material needed, the time required, the expected results. How will this action be evaluated ?

Tell the story

The story "the king, the young man and the food robbers" may be told to friends, to younger brothers and sisters and to parents. A play, or a marionette play, may be devised on the topic, and given to an audience of other students and parents, during the school fair.

EVALUATION

No matter what the size of the project, it must be evaluated at each step, from the preparatory phase to its conclusion. This makes ongoing monitoring of the course of events possible, so that any necessary changes may be made in due time.

We will confine our remarks to the educational evaluation done by the protagonists of the project : teachers, health officials, parents and the children themselves.

Project design

Decision-making

Here are several evaluatory questions that may be put at various phases of the project.

When the project was being designed, the decision was made to do a study on the ascaris, with the children's participation. The evaluatory questions may be : who decided what action to undertake, and why this one rather than some other one ? Were all of the people potentially concerned by this action consulted ?

This brings out the fact that the rural facilitator, who is working on a village sanitation project, was left out. It is decided that he should be invited to the next health committee meeting.

Evaluation of needs

In order to evaluate needs, the children undertook a preliminary survey to determine the prevalence of the disease in the population, what families know about the ascaris and what treatments are used traditionally. During evaluation, the question of who prepared the questionnaire may be raised, and whether the latter, written in French at school, was correctly translated by the children into their mother tongue.

The results show that some parents have expressed surprise at the fact that their children asked so many questions. It was decided that parents should be informed more completely on the work done by their children.

Definition of objectives

With respect to the definition of objectives, the evaluatory questions may deal with the difference between objectives aimed at knowledge, skills, attitudes and behaviour, and how clear each of these was. Was a clear, simple definition given of what children should learn, and is this knowledge adapted to these children and to their needs ? What means will be used to encourage children to change their attitude ?

Analysis of the results shows that there are no hand-washing facilities at school. It is decided that soap and water will be made available near the latrines.

Plan of action

The teachers, the health official and a few pupils have prepared a six-month plan of action, the main objective of which is to teach all pupils good personal hygiene and the proper use of latrines. Evaluatory questions may be : is the plan clear and adapted to the objectives ? Is it sufficiently flexible to be modified if needed ? Does everyone understand it well ?

The results show that the period covered by this project is too long, since attendance at school drops considerably once the rainy season has started. It was decided to shorten the period to three months.

During the activities

Evaluatory questions may include : are the facts communicated sufficiently easy to understand, and adjusted to the pupils' level ? Did all children participate in the surveys, discussions and other activities ? Did the teacher help the children to prepare the questionnaires, and to discover ideas for action at home and in the village ?

The results show that only some of the pupils had properly understood the health worker's explanations of how the ascaris is transmitted. It was decided that role-playing should be used to illustrate children defecating everywhere and anywhere, others with diarrhoea, flies perching on food, etc.

At the end of the activities

To evaluate what has been learned, achievements are examined.

Knowledge

It is discovered that no pre-test had been made to evaluate what children knew at the outset. This leads to the decision to use the results of the first survey as a pre-test.

Skills

Estimation of new skills is based on children's progress in observing what goes on around them, their curiosity, expressed by their ability to ask questions, and their sense of collective work.

The results show that not only have children learned facts about health, but that their classroom behaviour has improved. It is decided that the experience should be pursued, and other subjects broached.

Attitudes and behaviour

The health worker visits several homes to assess changes. Did the children convey the message to their family ? Did they act concretely, to improve habits contributing to cleanliness, especially those of younger children ?

Frequency of ascariasis

Decreased frequency of ascariasis in homes and in the community is also important for evaluation. Has the health worker noticed any changes since the start of these activities : increased demand for anthelmints, decreased number of cases of massive infestation, etc. ? Can this trend be ascribed to the Child to Child programme ?

Throughout this chapter, we have taken the example of a classroom education for health project confined to an extremely limited subject : the ascaris worm. Similar work may be done on other health-related subjects such as child growth and development, children's diet, malaria, AIDS, etc.

The Child to Child teaching method is not reserved for schoolchildren ; most of these activities may be used with children who are either too young to attend school or who have left school, as well as with adults, in the framework of functional literacy courses, for instance.

Furthermore, this action should be an integral part of a broader education for health programme aimed at the population at large, so that the messages coming from the school are in perfect consonance with programmes aimed at families and communicated through the medias, health workers, posters, etc.

It is not easy to set up a health education programme of this sort, particularly since this requires the establishment of a partnership between people who are unaccustomed to working together, such as teachers and health officials. This is an ambitious programme, but one which is extremely worthwhile. Today's children will be tomorrow's adults and parents : nothing can be more profitable than an investment in their education and health.

FURTHER READING

Bonati G, Hawes H (eds). Child to Child : a resource book. London : Child to Child Trust, 1992.

Child to Child Readers (Harlow : Longman) available from TALC (P.O. Box 49 - St Albans - Herts AL1 4AX - United Kingdom) on several topics : dirty water (level 1), good food (level 1), accidents (level 1), not just a cold (level 1), a simple cure (level 2), teaching Thomas (level 2), down with fever (level 2), diseases defeated (level 2), flies (level 2), I can do it too (level 2), deadly habits (level 3).

Hawes H. Child to Child, another path to learning. Unesco Institute for Education. Hamburg. 1988.

WHO. WHO model prescribing information : drugs used in parasitic diseases. Geneva, 1990.

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INTESTINAL PARASITOSES

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Intestinal parasitoses are still a major threat in disadvantaged areas, especially in those located in the tropics. Despite the difficulty in quantifying the human, economic and social cost of intestinal parasitic diseases, it is nonetheless evident that they deteriorate health and nutritional status at both the individual and the collective level.

And yet, the last few decades have yielded substantial knowledge of the epidemiological mechanisms, along with some effective although costly treatments, and in some cases, valuable preventive action.

In present times, parasitology remains a very relevant science, and will be particularly useful if it succeeds in integrating two key concepts, in addition to its present competencies, and putting them into practice. First, the ability to act on the environment in order to interrupt the cycles of transmission at the key points, through efficient, lasting action, which may be costly but is beneficial to the community as a whole. The second concept is the sharing and transmission of scientific knowledge and of skills and know-how with the population, from childhood on, in consonance with local situations.

"The daughter of the bootblack". Picture by Doctor Anne-Marie MASSE-RAIMBAULT. Quito (Ecuador)

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